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SPECIAL ARTICLE

THE FUNCTION OF THE SPLEEN

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AT LEAST UNTIL WE KNOW MUCH MORE THAN WE NOW DO OF THE SUBJECT, AN OCCASIONAL REVIEW OF OUR KNOWLEDGE OF THE FUNCTIONS OF THE SPLEEN IS WORTH WHILE. WHEN TO SUCH A REVIEW IS ADDED SOME APPARENTLY IMPORTANT AND CAREFULLY CONDUCTED RESEARCH, THE SUBJECT IS ENTITLED TO PROMINENCE.

IN OFFERING THIS ARTICLE FOR PUBLICATION, DOCTOR HALL STATES IN HIS LETTER OF TRANSMITTAL:

"UNDER SEPARATE COVER, I AM FORWARDING AN ACCOUNT OF SOME ORIGINAL WORK PERFORMED BY MYSELF AND A COLUMBIA GRADUATE CHEMIST. I BELIEVE THAT THE RESULTS OF OUR WORK ARE BOTH INTERESTING AND PRACTICAL, AND THROW, AT LEAST, A FEW RAYS OF LIGHT UPON THE TRUE FUNCTION OF THE SPLEEN.

"MISS ALBAHADIAN, WHO WORKED WITH ME CONTINUALLY THROUGHOUT THE EXPERIMENTS, GRADUATED FROM CHEMISTRY AT COLUMBIA, IN 1917, HAD TWO YEARS OF POST-GRADUATE WORK IN CHEMISTRY AT CORNELL UNIVERSITY, AND HAS PERFORMED HIGHLY SATISFACTORY WORK IN SEVERAL PRIVATE LABORATORIES IN CALIFORNIA.

"I GRADUATED FROM ALFRED UNIVERSITY, A BRANCH OF THE UNIVERSITY OF THE STATE OF NEW YORK, IN 1915, WITH A BACHELOR OF SCIENCE DEGREE, AND LATER TOOK UP MEDICINE, GRADUATING FROM THE COLLEGE OF MEDICAL EVANGELISTS IN 1920. SINCE GRADUATION, I HAVE BEEN IN ACTIVE GENERAL PRACTICE AT RIVERSIDE, WITH THE EXCEPTION OF THE PAST TEN MONTHS, DURING WHICH TIME I HAVE BEEN IN GLENDALE, CALIFORNIA. I AM A MEMBER OF THE COUNTY, STATE, AND NATIONAL MEDICAL SOCIETIES.

"IF YOU CARE TO READ THIS ARTICLE, WE SHALL BE PLEASED, AND IF YOU DECIDE TO PUBLISH IT IN PART, OR IN WHOLE, IN CALIFORNIA AND WESTERN MEDICINE, WE SHALL, OF COURSE, BE GREATLY PLEASED.

"WE SEND THE ACCOUNT OF OUR WORK TO YOU WITH THE IDEA OF SPREADING THE PRACTICAL INFORMATION WHICH WE FELL UPON BY ACCIDENT AND DEVELOPED BY MUCH HARD WORK."—EDITOR.

*T*HERE is just one finding in common in all the list of conditions that are known to have splenic hypertrophy, or splenomegaly, so-called.

The spleen may have something to do with hemolysis; it may have something to do with the elaboration of uric acid; it possibly is an important lymphatic gland, but, above all these functions, we wish to place its action as a calcium metabolism stimulant, preparing suitable calcium salts for presentation to the blood stream and the impoverished body cells.

12 centimeters; breadth, 7 centimeters; thickness, 4 centimeters; and that its weight is approximately 160 grams, would be repeating facts that can be readily found in all of our standard anatomy books.

Let us, for a moment, look over the possibilities that the spleen has had in the field of medicine from the supposititious standpoint entirely. This organ was supposed to have something to do with the elaboration of iron, probably set free after the demolition of the red corpuscles. This gland was also implicated for a time in the production of uric acid. A digestive function was also attributed to the spleen and its hormones, for it was observed, in some instances, that the gland enlarged after meals, reaching its maximum at approximately the fifth hour after eating. Enlargements of the spleen have been observed in practically all of the fevers, especially those of the intermittent type.

Mr. Raymond Householder of Chicago, in 1921, experimented with guinea pigs, and in a long series

*T*HE authors of this article had for some time felt that the spleen must have some worthwhile function, and set to work about a year ago to carry out some very definitely planned campaigns into the splenic area to see if the spleen were worth anything, and, if so, for what.

A great deal has been written about the spleen, pro and con. Many functions have been attributed to it and it has been endowed with all sorts of possibilities, as, for instance, a graveyard for the red blood-cells; also as one link in the lymph glandular chain. The upshot of the whole matter has been that, for a long time, the only definite thing known about the spleen was its average size, weight, and anatomical position in the body. For us to state, for instance, that its average length is

of cases found that the subcutaneous injection of hydrochloric acid caused splenomegaly. This author and experimenter, in his conclusions, infers that this enlargement could possibly be due to the increased destruction of red cells which must accompany this artificial acidosis, and yet wavers also toward the belief that the gland was perhaps hyperfunctioning as a hematogenic gland to offset this same anemia.

Other experimenters (Ott and Scott of The Medical Chirurgical College of Philadelphia) have tested certain of the animal extracts, as well as other drugs, and their influence upon splenic size. Infundibulin (pituirin) was shown to decrease primarily the volume of the spleen and then to cause an exaggeration in its size. No relation between blood-pressure changes and splenic size was demonstrated. Pineal solution was tested and found to cause a diminution in the size of the spleen, after which the gland returned to normal. Thymic infusion had the same action, as did also infusion of the ovaries. Corpus luteum in solution produced an increased volume in the gland, which shortly became normal. Infusions of mammary tissue and dried pancreas had no action upon splenic volume. The results from injections of quinin hydrochloride were not of a nature to establish any definite reports, for, in some instances, the spleen increased, and in others decreased in size. Probably all of the above changes can be explained from blood vascular changes of the vasomotor type, as, for instance, when adrenalin or infundibulin were used.

Can we say, then, that the spleen has an internal secretion or hormone? Does it break up red cells because of a true hormone or because of a secretion of the digestive type that breaks down red blood corpuscles or disease germs, as the case may be? Can we not explain some of its functions by stating that it produces phagocytes which devour invading organisms and by a rapid elaboration on the part of the splenic laboratory may fill the blood stream with a normal amount of white cells in ordinary existence and an overamount in certain of the lymphatic leukemias, for in such cases we find a splenomegaly? Whether this action of the spleen in relation to blood cells is endocrine or not we may never be able to state, but we do know that the results of splenectomy are very satisfactory in certain splenic anemias and in hemolytic jaundice.

Inlow, at the Mayo Clinic, some years ago carried out a series of experiments to show the effects of splenectomy upon digestion, with particular reference to the flow of bile and the production of bile acid. He concluded that there is an increase in the outflow of bile after splenectomy, constituting an amount about one-fourth above that produced in the normal animal. The findings vary, however, when the time element is considered. Shortly after splenectomy, there is an increase in the output of bile, and along with this there is a concomitant rise in the hemoglobin content of the blood, and also in the red blood-cell count. All of this is later followed by an anemia and a reduction in the amount of hemoglobin, with more or less change in the flow of bile, usually more readily observed in late cases. His most dependable finding was that the regular fluctuation in the flow of bile and in the blood condition is accentuated by splenectomy.

Whether these findings are practical or not, we are unable to state. They are of academic interest at least. Other investigators at the Mayo Clinic have shown that the spleen may at times serve as a reservoir for the retention of syphilitic spirochetes, and, just for the moment, it is pleasing to know that the removal of such spleens is attended by a rapid change for the better on the part of the patient. Things may turn for the worse later, but, in many instances, there is an apparently satisfactory result following splenectomy in these individuals. This same clinic removed a large series of spleens in pernicious anemia, but the results were so discouraging that the procedure has been discontinued for the relief of this particular disease.

Dr. Reginald Weiler, of New York City, has given us an exhaustive discussion of the so-called spleno-pancreatic apparatus, and his conclusions would evidently show that it has a definite relation to the endocrine apparatus in general. The relation of the circulation to both glands is such that he believes that trypsin should be called the spleno-pancreatic secretion (a true internal secretion), "which reaches the portal vein by the way of the splenic vein and which continues in the blood stream the splitting process begun in the intestinal canal." That the spleen may have, therefore, something to do with the elaboration of insulin would be indicated by the fact that the islands of Langerhans are three times as numerous at the splenic extremity of the pancreas as in other parts, and, further, at the terminal portion of the descending arm, where there is no communication with the splenic vein, there are no islets. The author is sure that the splenic vein serves as "a channel for the transmission of pancreatic and splenic ferments of the liver. Trypsin becomes a constituent of the entire blood stream where albuminoids are broken down into simpler bodies."

There are many causes for the enlargement of the spleen. Osler has given us an exhaustive list of the causes of splenomegaly. This is perhaps worthy of repetition at this time. It serves to show the great number of conditions varying from some of the metabolic disturbances in childhood to violent infections which have to do with splenic disturbance. It is as follows:

I. In children: (a) Disturbances of metabolism, rickets, amyloid disease; (b) Chronic intestinal affections; (c) Large but ill-defined groups of intestinal disorders, particularly in the tropics; (d) The pseudo-leukemia infantum (Von Jaksch's disease).

II. In the infections: (a) Syphilis; (b) Malaria; (c) Kala-azar and other forms of tropical splenomegaly; (d) Hodgkin's disease; (e) Tuberculosis.

III. In primary disorders of the blood-forming organs: (a) Leukemia; (b) Pernicious anemia; (c) Chlorosis; (d) Hemachromatosis; (e) Polycythemic splenomegaly.

IV. In cirrhosis of the liver: (a) Syphilitic; (b) Alcoholic; (c) Hypertrophic of Hanot.

V. Hereditary and family forms of splenomegaly: (a) Congenital acholuric icterus; (b) Constitutional disturbances, dwarfing, etc.

VI. New growths and parasites: (a) Sarcoma; (b) Primitive endothelioma of Gaucher; (c) Echinococcus; (d) Schistosoma of Japan.

VII. Splenomegaly not correlated with any of the above or with any known cause: (a) Banti's disease in its three stages: 1. Simple enlargement; 2. Splenomegaly with ane-

mia; 3. Splenomegaly with anemia, jaundice, and ascites.

European writers have given us quite a large number of reports of the findings in animals either splenectomized or treated with splenic solution. Some of these writers, as, for instance, Bayle of Cannes, is certain that the splenic function has to do with the development of antibodies and immunity. This investigator treated a large number of tuberculous cases with a splenic preparation, and, in his first paper, read at Rome before The Congress of Tuberculosis, in 1912, he says: "I feel authorized by my results to call splenic opotherapy a specific treatment for tuberculosis. . . . From the therapeutic standpoint, it modifies the soil, rendering it less suitable for the growth of the bacillus of Koch." This statement is very sweeping, and it is not our purpose to comment on it here. We are giving this report purely to show the belief this physician has in the function of the spleen. Quoting further from this author, we find: "Employed in convalescence, it prevents tuberculosis by increasing the mineral content of the tissue." He even makes more definite statements than this, and his belief that splenic solution or extract has a certain control of tuberculosis is one the writers could accept only after greater personal experience with this form of therapy. More of this later, however.

Hans Sollberger tells us that, after splenectomy in normal rabbits, there is an increase in the hemoglobin figures and also in the number of the red blood corpuscles, perhaps due to the reduction of hemolysis which must take place if we are to accept the original theory of the "graveyard" possibilities in the splenic reservoir. Sollberger believes that, after splenectomy, the bone marrow is more sensitive and has a greater working capacity, perhaps due to the removal of one party in a balanced action, the idea being that there is a mild antagonism, or ratio, at least, between the blood-destroying spleen and the blood-forming bone marrow. To prove this latter-mentioned theory, he injected hydrogen cyanide subcutaneously in normal and splenectomized animals. We know that the action of this powerful poison is hemolytic to a marked extent. Just why he chose this particular drug, we do not know, but, at any rate, it gave immediate depression in the amount of red blood corpuscles and hemoglobin in all animals treated. The normal animals were very slow in securing their former hemoglobin and red blood corpuscle figures, whereas the splenectomized animals, with readily active bone marrow, produced blood corpuscles rapidly and arrived at normal figures as to blood content much more readily than their normal fellows. Sollberger is confident that the ready increase in hemoglobin and red blood corpuscles is due to the rise in the efficiency of the marrow of the splenectomized animal. This same investigator removed the thyroids in rabbits to find, if possible, a compensatory change on the part of the spleen. He does not report any change in size or texture of the latter gland, but says that there is probably a non-specific stimulation of blood-forming organs, for he noted an increase in the formation of hemoglobin after thyroidectomy. These are interesting findings, but again of a purely academic type. We must remember, however, that the position of small straws

can readily indicate the direction in which the wind is blowing. To many, this idea of a balance between the spleen and bone marrow is new, and, while theoretical, is still sensible and worthy of consideration in certain diseased conditions. The ready relief in Banti's disease, in any stage, following splenectomy is a vindication of this idea.

Schröder, Kaufman, and Kögel have tested spleen pulp as a direct media for implantation of tuberculous cultures, and report that virulent tuberculous bacilli are weakened at the normal breeding temperature in such a media, and many of them are destroyed. Complete destruction or solution of the tuberculous bacilli was not noticed. The anti-tuberculous value of the spleen must be rather worth considering, for we know, not only from the findings of these investigators, but from the generally accepted principles in our own United States that the body of an animal is considered to be saturated with tuberculosis only when the spleen itself is thoroughly involved. In other words, when we have marked splenic tuberculosis, we have an organism whose resistance has been completely overcome in regard to Koch's bacillus, and that is why inspectors in our slaughterhouses throughout the country investigate the spleen in all cases first. The anti-tuberculous action of the spleen and its secretion is one that has aroused the attention of a large number of investigators other than those just mentioned—a function that we believe is worthy of further investigation, particularly after some experiences we have had in the last year or so. The proof of the value of splenic therapy is to be found, we believe, in clinical and animal experimentation rather than *in vitro*. In animals treated with splenic extract, there is a change that is readily observed and apparently consistent throughout the numerous resultful experiments.

Walter Frey and Erich Hagemann have brought forth a clinical test, which we believe is fairly delicate, to determine the functional capacity of the spleen. The test consists in injecting from 0.6-1 mg. of adrenalin subcutaneously and then counting the number of lymphocytes twenty minutes after the injection of the adrenalin. In cases who have a diseased or hypofunctioning spleen, the lymphocyte increase will be less than 1500 cells within the twenty-minute time limit. The results of this test cannot be considered absolute, but should be taken along with the general findings in the case. These two writers reported a series of sixteen patients tested with the adrenalin-lymphocytosis procedure and found only one doubtful result. In all the remaining fifteen cases, the reaction was accurately diagnostic of the true splenic condition: i. e., the positive reactions were present in those patients who had a normal spleen and the negative reactions in all instances were attended by a diseased spleen. We do not believe that this test is being used to any great extent in the United States, and we deem it worth while to consider it in cases in which we would like to know whether or not the spleen is diseased for obvious reasons.

From the Italian sector we have some recent reports from T. Silvestri, in which he reviews, as a result of his own experiments, some of the actions of the spleen, and also tells us of some of the origi-

nal digestive experiments which he is confident show a relation between splenic function and pancreatic secretion. In this review he tells us that the function of the spleen is partly to furnish the peptic glands with material of great importance to their normal functioning, although this particular substance is not indispensable, for pepsin is readily formed after a period of readjustment in splenectomized animals. He believes, however, that gastric digestion is never as active after splenectomy as before. In other words, there is a constant hypopepsia, but the other principles of the gastric juice remain unchanged. He tells us that the gastric ferments can be corrected quite readily by splenic organotherapy. The translator does not tell us, in the article which we have at hand, whether or not the splenic extract was given by hypodermic or by mouth. We should like to know more about the method of administration. The general principles involved, however, are interesting and worth recording here.

We are told further in this report from Silvestri that the three enzymes found in the internal secretion of the pancreas are unaltered by splenectomy. He states, however, that albuminoids are not digested by the pancreas after splenectomy, but the powers of the gastric juice, so far as the splitting of albuminoids are concerned, is markedly increased under the same conditions; and, further, we are told that this increase may become very great, perhaps making up for the simultaneous loss of that function on the part of the pancreas. This would lead us to believe that there is some relation between the pancreas and the spleen. As we have already stated, there is a circulatory arrangement between the two glands which definitely controls the location of the Langerhansian isles, for the portion of the pancreas, which extends beyond the spleen and is not connected with it in a circulatory way, has none of these specialized islets.

After looking over the previous discussion, many of us will be willing to agree with William Osler, who said that he enjoyed reading an article concerning the splenic function which contradicted a previous article on the same subject, for he had never been able to assure himself that the spleen had a definite business in life. Yet, we must not say that the work that has been done in this field was inaccurate or done in a slipshod manner. The rather elusive function of the spleen has aroused the interest of many men whose time could well be spent in research work, and they have contributed here and there some ideas that, while at first appearance may be antagonistic in the final expression of fact, yet we believe are capable of being correlated under proper headings; at least, we wish to make an attempt to do so, in view of the very definite findings that we have had in our experiments with splenic solution, and in which we considered an entirely new phase of action.

We believe that this attempt is worth while, for we find, as an expression of the common belief in splenic unimportance, the following paragraph taken from an editorial appearing in *The Journal of The American Medical Association*, January 7, 1922:

"Taken all together, an enormous amount of experimental work, as well as not a little careful clini-

cal study, has failed to show conclusively that the spleen is an organ of internal secretion, or to account in any way for the fact that it is a large organ, universally distributed in the animal kingdom, provided with a blood supply so large as to suggest that it must have great activity and most important functions. Whatever it does in the way of destroying decrepit red cells can be done elsewhere. Surely it must have some further task than this; yet, if it has, this must be readily carried on in other tissues, since splenectomy is so well endured; probably this is why we cannot find out just what the chief function of the spleen may be."

The material thus far placed in paragraph form for the reader's interest has been by way of preparation, so to speak, for our original work. We had originally begun our work with splenic extracts to test their action in cases of tuberculosis. This was due to the belief we had in their possibilities in this type of infection, not so much from personal experience as from observing the writings of others, and also from some discussions we had had with physicians who were beginning to become enthusiastic about this particular endocrine, if endocrine it is. Purely by accident, Miss Abalahian discovered that the rabbits who had received intravenous splenic extracts were showing some phenomenal increases in blood calcium. The blood calcium tests were being performed at the time to produce, if possible, a briefer clinical method for determining blood calcium—a matter that had been brought to the attention of the medical profession by the work of Drs. Vines and Grove, of Cambridge University, England, who had been working with parathyroid extracts. So sharp was the increase of blood calcium in the animals receiving splenic extract, that a series of them were immediately placed upon this solution, the blood being tested at regular intervals for its calcium content. We were soon very much surprised to find that all of the rabbits placed on splenic treatment were found to have an increase in blood calcium; in fact, this increase was found to be several times greater than in rabbits who received parathyroid nucleoprotein by vein. We shall proceed, then, to give you some of the information that we have gathered during the last nine months after exhaustive experimentation and accurate laboratory work.

It is evident that an injection of spleen nucleoprotein causes the outpouring of a shower of ionic calcium in the blood stream. This increase in blood calcium is fairly rapid and reaches its greatest height in about twenty-four hours after the injection. In from twelve to fourteen hours more, the findings are, in terms of calcium, again practically normal, never becoming subnormal. It is evident from our findings that any excess of lime in the blood is shortly eliminated by the kidneys, and that is our main idea in adding a small amount of parathyroid substance to the splenic solution, since the parathyroid preparation evidently acts as a mordant to hold the excess calcium in the blood and to prevent its rapid elimination. We can readily see that the actions of splenic substance and that of parathyroid substance are, while similar in many ways, very different when it comes to the elimination of calcium. By combining the two preparations, we have a re-

markable stimulant to the chemistry of blood calcium and a hormone whose activity already has been demonstrated as being a conserver of blood calcium.

The following tables will show that the calcium is markedly increased after the injection of spleen solutions intravenously. In several instances as great a change as three milligrams was observed after the injection of splenic hormones, and in almost no instance have we observed a decrease in blood calcium. It seems that the reaction is very dependable:

Rabbit No.	Normal Calcium	Calcium after 2 injections	Calcium after 5 injections
4	14.40	15.42†	
4	14.78		15.00†
5	14.41		14.93†
6	15.9	15.80†	
6	14.43		18.20†
7	16.9	16.20†	
9	15.3	16.0*	15.6*
10	16.5	20.0*	17.4*
11	15.0	18.5*	15.2*
12	16.0	17.0*	22.1*
13	15.0	16.0*	19.6*
14	16.0	15.5*	21.0*

* Figure produced by spleen injections, 1 cc. daily.

† Figure produced by injections of a combination of splenic and parathyroid extracts, 1 cc. daily.

Blood-cell increases have been observed after the injection of spleen nucleoprotein. Contrary to the old belief that the spleen has a hemolytic action, it was found that the red blood-cells increased in some instances over one-half million in a few days' time and, further, that the blood hemoglobin was increased, as would be expected when the red blood-cells were augmented in numbers.

The clotting time was shortened markedly in every case. This was noticed very readily when drawing blood from experimental animals. In some instances, the blood clotted so readily that it was withdrawn from the marginal ear vein with considerable difficulty, the wound having to be freshened frequently.

Two rabbits were splenectomized and their blood tested at intervals for its calcium content. In both rabbits thus treated, the blood calcium dropped almost 50 per cent. A control animal was cut open and sewed up without tampering with the spleen or any of the other abdominal viscera. In this rabbit no change was noted in the blood calcium. The two splenectomized rabbits were given intravenous injections of spleen solution, after which the blood calcium came to normal.

In keeping with the foregoing considerations, a series of tuberculous patients was placed on splenic extract therapy (by hypodermic administration) with some satisfactory changes in the blood calcium findings. These patients thus far have been observed for a period of a little over one month. The clinical findings have not been changed markedly. The physical findings will probably respond more slowly to treatment in tuberculosis than in any other condition on account of the marked chronicity of the infection and the usual long periods of toxemia preceding the tests.

Further experiments must be carried out in tuberculosis to find, if possible, a strength of solution that can be used which will be comparable to the severity of the symptoms of the disease. Ordinary strengths of splenic extract are probably not sufficiently active for Koch's infection. Ordinarily, a 4 or 5 per cent

solution has been used. If we can double that in this condition, well and good. That particular problem remains to be solved.

We believe one of the possibilities of treatment with this solution lies in inhibiting a tendency to hemorrhage in pulmonary tuberculosis, as injections of solutions of spleen shorten the clotting time in a few hours after the injection.

It is evident that spleen solutions, when injected into the human economy, cause an outflowing of calcium which is constant, marked, and readily produced. Further, it is evident that this rapid increase of calcium will be followed shortly by a loss of that particular substance due to elimination and lack of a supply. Since parathyroid is capable of fixing the blood calcium and of preventing its undue elimination, a combination of parathyroid (the calcium conserver) and spleen will be an ideal one for use in all calciprivic states, including tuberculosis.

May we call your attention to the fact, then, that there is just one finding in common in all the list of conditions that are known to have splenic hypertrophy, or splenomegaly, so-called? If we look down through the list of diseases given by Osler, we can, at least, say that there is one thing in common in all of those disturbances, and that is calciprivia, demineralization, or acidosis, depending upon the reader's personal choice of a term indicating lack of alkali reserve, and, therefore, a need for calcium ions. The spleen may have something to do with hemolysis; it may have something to do with the elaboration of uric acid; it possibly is an important lymphatic gland, but, above all these functions, we wish to place its action as a calcium metabolism stimulant, preparing suitable calcium salts for presentation to the blood stream and the impoverished body cells.

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Conference Board of Physicians in Industry—At a recent meeting of this interesting organization, it was agreed that many trifling injuries created no disability and required no redressing, but that many serious infections, entailing much loss of time and production, arose from the neglect of such patients. . . . Over 2000 infection cases were reported among 32,500 workers during 1924, and of this number only about twenty had received treatment prior to the appearance of the infection. It was thus seen that where prompt medical attention is given to injuries, infections are practically eliminated, and that practically all infections in such injuries result from delay in reporting for treatment. In the experience of the members of the conference the most beneficial results to the worker who is recovering from an injury are obtained in cases WHERE HE IS RETURNED TO EMPLOYMENT PENDING COMPLETE RECOVERY. Certain types of workers are unfavorably influenced by prolonged periods of idleness pending complete recovery, and it is hard to get such persons to again take up their usual employment. It was the unanimous conclusion of the board that the practice of permitting the worker to unduly prolong his idleness was a factor in delayed recovery and the development of traumatic neurosis and certain cases of malingering. In many patients a certain amount of physio-therapeutic treatment is necessary before any work can be attempted, but the board believes that supervised active motion of the previously injured part, carried out as work in the factory, also leads to more prompt recovery.

KIDNEY ANOMALIES: REPORT OF A CASE OF BILATERAL FUSION OF A SUPERNUMERARY KIDNEY

By WILLIAM E. STEVENS, M. D., San Francisco

Examination of available literature fails to reveal a previously published case.

Bilateral fusion and horseshoe kidneys not the same in etiology or pathology.

If one chooses to classify the reported case as horseshoe kidney, it is still unique.

DISCUSSION by Louis Clive Jacobs, San Francisco; Burnett W. Wright, Los Angeles; A. S. Musante, San Francisco; E. Spence De Puy, Oakland.

Doctor Stevens supplies, with his interesting article, a complete bibliography of previous publications on the anomalies of kidneys. Under the policies of CALIFORNIA AND WESTERN MEDICINE, and most other general medical journals, bibliographies are not published. Workers interested in studying the subject more fully will gladly be supplied with a copy of the bibliography by the secretary of the California Medical Association or by Doctor Stevens.

I wish to utilize this opportunity to again call the attention of readers to the great assistance of the Cumulative Index of all worth-while medical literature published quarterly by the American Medical Association and furnished at a nominal subscription price.—EDITOR.

S anomalies of the kidney are more frequently encountered than those of any other organ, these conditions are of special interest to the urologist, and the possibility of their occurrence should always be considered in the presence of obscure lesions of the abdomen or upper urinary tract.

In 4215 consecutive autopsies, Lowsley, Kingery, and Clarke found 1.47 per cent of renal anomalies. In the records of 11,168 autopsies, Morris found abnormalities of the kidney in 211 subjects, a little less than 2 per cent. This author collected from the literature between 1883 and 1893, 21 cases of various malformations. Of these, 8 were horseshoe kidneys, 11 single, and 2 unilateral fused kidneys. Dorland, in 1911, collected 121 cases of renal anomalies which had been reported in the literature during the preceding twelve years. He added two of his own. Of these, 36 or 29.2 per cent were horseshoe kidneys, 24 or 19.5 per cent were single kidneys, 14 or 11.2 per cent unilateral fused kidneys, and only 5 or 4 per cent supernumerary kidneys. Eight of the third group were classified by Dorland as sigmoid kidneys, and six as disc-shaped kidneys. The former are now usually included with unilateral fused kidneys. Of these 123 cases, the sex was stated in 66; 53.2 per cent of the 123 occurred in males, and only 28 per cent in females. The left kidney was affected in a little over 70 per cent. In 1905, Gerard, quoted by Dorland, studied 527 cases of renal anomalies. He arrived at practically the same conclusions.

Considered from a standpoint of variation in number and form, these anomalies are, therefore, in the order of their frequency, horseshoe kidney, single or solitary kidney, unilateral fused kidney, and supernumerary kidney. Atrophic, displaced or ectopic kidneys and reduplication of the pelves and